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THE EFFECT OF CERTAIN PHARMACOLOGICAL REMEDIES ON
VISUAL ACUITY UNDER CONDITIONS OF FAINT ILLUMINATION AND
REDUCED BAROMETRIC PRESSURE

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It is known that, under conditions of reduced barometric pressure corresponding to altitudes of 5,000-6,000 meters above sea level, there occurs a more or less clearly defined decrease in visual acuity (Heller, Belostotsky, Fedorov).

N. G. Fedorov repeated and elaborated on the studies of a series of American authors (MacFarlan, Farbest and Evans) by administering glucose to improve the condition of people at high altitudes, and obtained clearcut improvement of visual acuity in weak light and reduced barometric pressure after giving glucose to subjects at the level of 1 gram per kilogram of weight.

D. G. Rosenbloom, S. I. Subbotnik, et al, administered caffeine and cola nuts with the purpose of raising light-sensitivity of the dark-adapted eye and obtained a distinct positive effect.

In 1943, on the suggestion of the Commission of Military Physiology attached to the Medical Council of the Soviet Narkomzdrav USSR, we undertook several series of experiments using conditions of reduced barometric pressure and illumination of 0.5 meter-candle unit (lux) to test the influence on visual acuity of phenocoll, ascorbic acid, caffeine and methyl caffeine (recently synthesized by Ye. S. Golovchinsky in the VNIKhFI). We undertook upwards of 150 experiments, not counting controls, on six medical students and two flyers, aged 18 to 24.

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Method of Investigation

The subjects (no more than two at a time) were placed in a dark room and adapted to weak illumination for 20-25 minutes. After this, at intervals of 5-10 minutes, visual acuity was determined at constant atmospheric pressure in a background atmosphere of noise from an enclosed motor and of a pump. After receiving 2-3 constant values for visual acuity, equal under the conditions of our illumination to approximately 0.3 meter-candle unit (lux) the "ascent" was begun. The predominant majority of tests were undertaken at a height of 4,500 meters.

We administered phenocoll in varying doses, stopping finally at 20 mg (2 tablets of 10 mg).

Crystalline ascorbic acid was administered to the subjects as a powder, directly on the tongue, in a quantity of 250-300 mg. A series of tests was undertaken where ascorbic acid was administered in wafer form. Caffeine and methyl caffeine were given experimentally in 100-mg doses.

Results of Experiments

After establishing the background and the character of changes in visual acuity in the subjects under the conditions of our experiments, and training in the transmission of signals indicating discernment of corresponding Landolt discs, we began a series of tests, giving oxygen in various modifications. The tests showed that (a) inspiration of oxygen restores visual acuity, decreased under the influence of reduced barometric pressure; (b) inspiration of oxygen begun before ascent prevents decrease in visual acuity up to an altitude of about 9,000-10,000 meters; (c) at an altitude of 10,000-12,000 meters the inspiration of oxygen does not completely restore visual acuity; (d) during a stay of the subjects at an altitude of 4,500 meters upwards of an hour the administration of oxygen to them does not restore visual acuity to the original value specific for that particular intensity of illumination. (See Table, Case 1).

Then we proceeded to test the effect of administration of phenocoll to the subjects. We established that (a) phenocoll in a dose of 20 mg quite clearly increases visual acuity up to the original level in cases of its reduction under conditions of a deficit of oxygen in inhaled air (we failed to record increase or decrease in visual acuity under the influence of phenocoll administered in a background of weak illumination, and normal barometric pressure); (b) prophylactic (before ascent) administration of phenocoll does not prevent a diminution of visual acuity, although on subsequent lowering of barometric pressure it moderates the extent of diminution; (c) a positive effect develops within 20 minutes after the dose of phenocoll and is retained during the course of 60-80 minutes of the subsequent stay at an altitude. (See Table, Case 4).

In the following series of experiments we studied the effect of crystalline ascorbic acid on visual acuity. We established that immediately after a dose of ascorbic acid there follows a distinct increase in visual acuity, and then a rapid decrease followed only after 15-20 minutes by a steady rise which lasts for the course of the next 1-1½ hours (See Table, Case 8). We considered that this double-phase action of ascorbic acid was connected, first, with the already well studied (Makarov, Kekcheev et al) reflex effect from taste receptors of the oral cavity on the exciter of the brain centers of viewing agent, and second, with specific more retarded and extended effects of ascorbic acid as a vitamin.

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To examine this hypothesis we carried out a series of tests giving the subjects directly on the tongue 300 mg of tartaric acid and we received a quickly passing and sharply defined increase in visual acuity. In another series of experiments our subjects received ascorbic acid in wafers. In these cases we did not detect the first phase of the improvement in visual acuity, which rose only within 20-30 minutes after the dose.

The last group of tests were undertaken with caffeine and methyl caffeine (8-methyl caffeine).

We established that (a) caffeine briefly increases visual acuity 15-20 minutes after a dose; (b) in the case of methyl caffeine, although it does not give such a sharp increase in visual acuity as does caffeine, its effect on the other hand lasts steadily for more than an hour. Caffeine and methyl caffeine taken 30 minutes before ascent prevents decrease in visual acuity which results under conditions of ascent to an altitude (See Table, Case 15).

Beside the enumerated drugs we tried various combinations of them. Generally better results under the conditions of our experiments were obtained by giving the subjects ascorbic acid with phenocoll or with methyl caffeine. Visual acuity with these combinations was maintained at a higher level for a more protracted time. In all cases, when we wanted to get a quicker effect from a dose of a certain drug or combination of drugs, we gave the subjects powders with a supplement of tartaric or ascorbic acid which we spilled out directly on their tongues, bringing about in the course of the first minute an increase of visual acuity which was supported later by a specific influence of the substance in question.

Data of investigations embodying this final modification of the tests will be described in a forthcoming work.

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Case 1. Subject M				Case 4. Subject Ts				Case 8. Subject K				Case 15. Subject I			
Time	Altitude (in m)	Visual Acuity		Time	Altitude (in m)	Visual Acuity		Time	Altitude (in m)	Visual Acuity		Time	Altitude (in m)	Visual Acuity	
9 h 45 m	ground	0.29		8 h 30 m	ground	0.32		8 h 10 m	ground	0.26		7 h 34 m	ground	0.38	
9 " 55 "	"	0.29		8 " 35 "	"	0.29		8 " 20 "	"	0.29		7 " 44 "	"	0.38	
10 " 05 "	ascent			8 " 40 "	ascent	0.30		8 " 29 "	"	0.29		7 " 45 "	"		
10 " 10 "	4,500			8 " 45 "		0.30		8 " 40 "	ascent	0.29		7 " 47 "	ascent		
10 " 15 "	4,500	0.26		8 " 55 "	4,500	0.24		8 " 47 "	4,500			7 " 54 "	4,500		
10 " 20 "	4,500	0.15		9 " 05 "	4,500	0.20		8 " 54 "	4,500	0.35		7 " 57 "	4,500	0.42	
10 " 32 " 1	4,500			9 " 15 " 2	4,500	0.18		9 " 04 "	4,500	0.32		8 " 07 "	4,500	0.42	
10 " 35 "	4,500	0.26		9 " 30 "	4,500	0.23		9 " 16 "	4,500	0.42		8 " 20 "	4,500	0.42	
10 " 40 "	ground	0.31		9 " 40 "	4,500	0.26		9 " 27 "	4,500	0.32		8 " 30 "	4,500	0.42	
10 " 45 "	"	0.30		9 " 50 "	4,500	0.32		9 " 37 "	4,500	0.29		8 " 33 "	descent		
				9 " 55 "	descent			9 " 47 "	4,500	0.29		8 " 40 "	ground	0.38	
				10 " 00 "	ground			9 " 48 "	descent						
								9 " 58 "	ground	0.29					

1. Given oxygen. 2. Given 20 mg phenocoll. 3. At 8:15 given 300 mg ascorbic acid. 4. Given 100 mg methyl:caffaine.

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